

A New Calibration Technique for Raman Lidar Water Vapor Data

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Outline

1. Introduction
2. System Description
3. New Calibration Algorithm
4. Algorithm Sensitivity
5. Asymmetrical drying around hurricanes
6. Conclusions

Introduction

- 10 years of measurements
- Calibrate from first principles – Limited by knowledge of Raman scattering cross sections
- Calibration to other sensors – less error
- Want more physical calibration method
- Aug-Sep 1998, CAMEX-3, Andros Island, Bahamas
- Many cumulus clouds
- Well-mixed Boundary Layer (Marine)

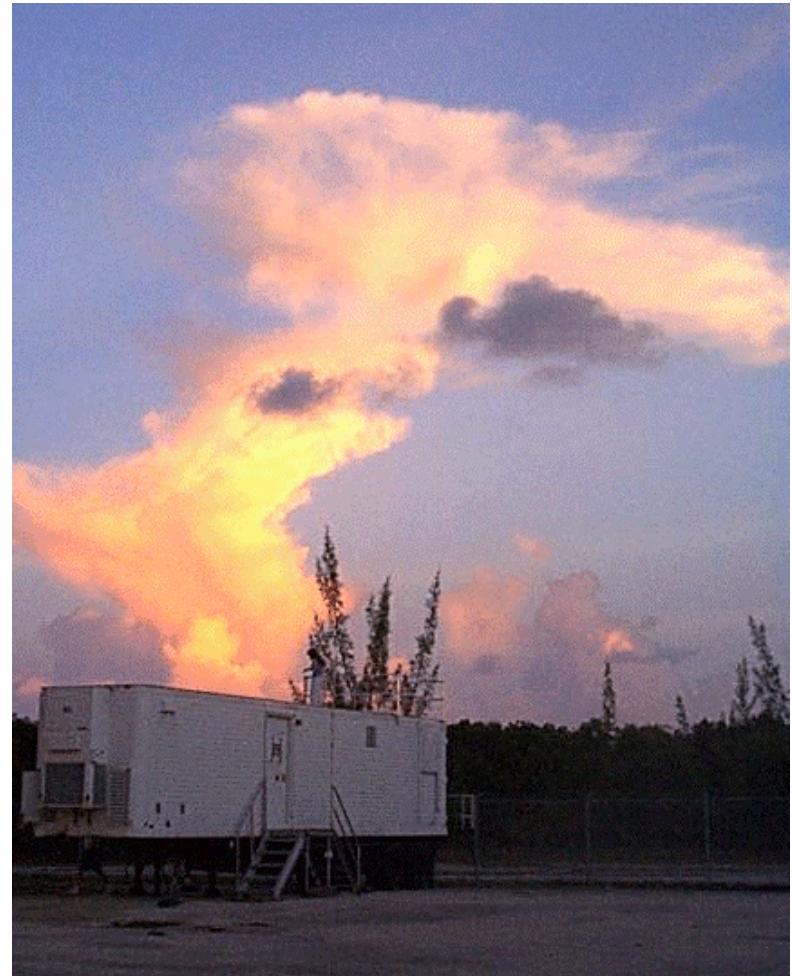
NASA/GSFC Scanning Raman Lidar

- XeF excimer laser, 351 nm
- 30-60 mJ per pulse, 400 Hz
- 76 cm Dall-Kirkham telescope

Collects backscatter from

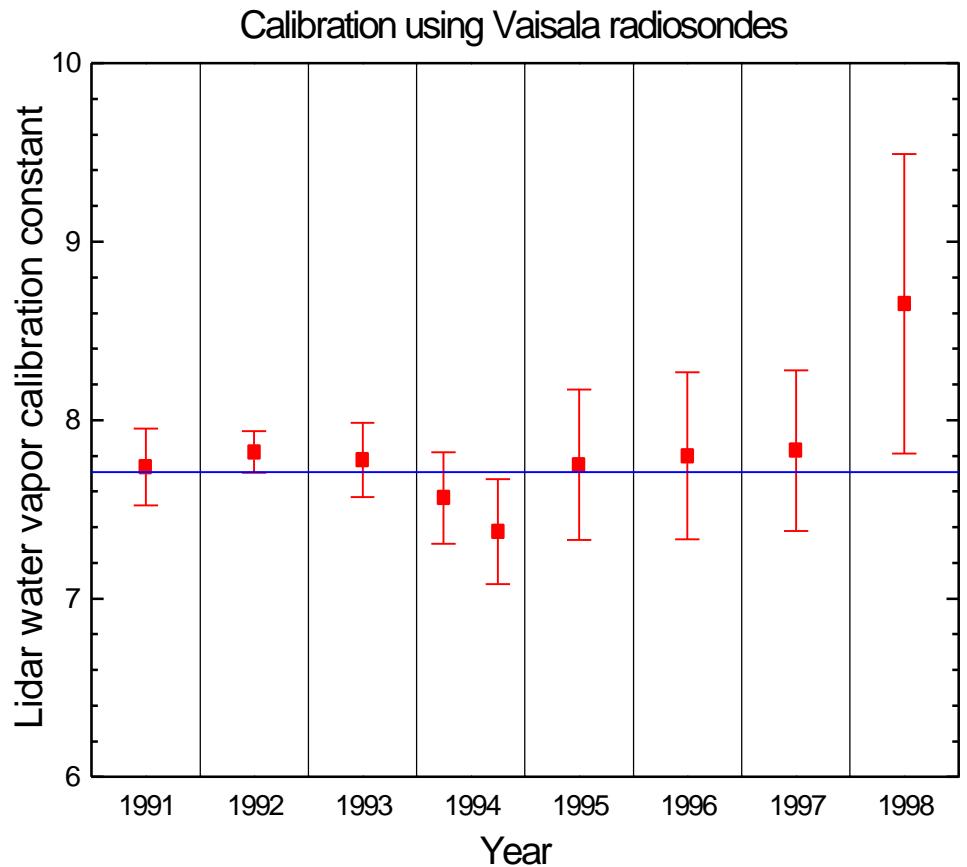
- Molecules and particles
- Raman-scattered oxygen
- Raman-scattered nitrogen
- Raman-scattered water vapor

- Low & high sensitivity channels
- 1 minute profiles
- 75 m vertical resolution

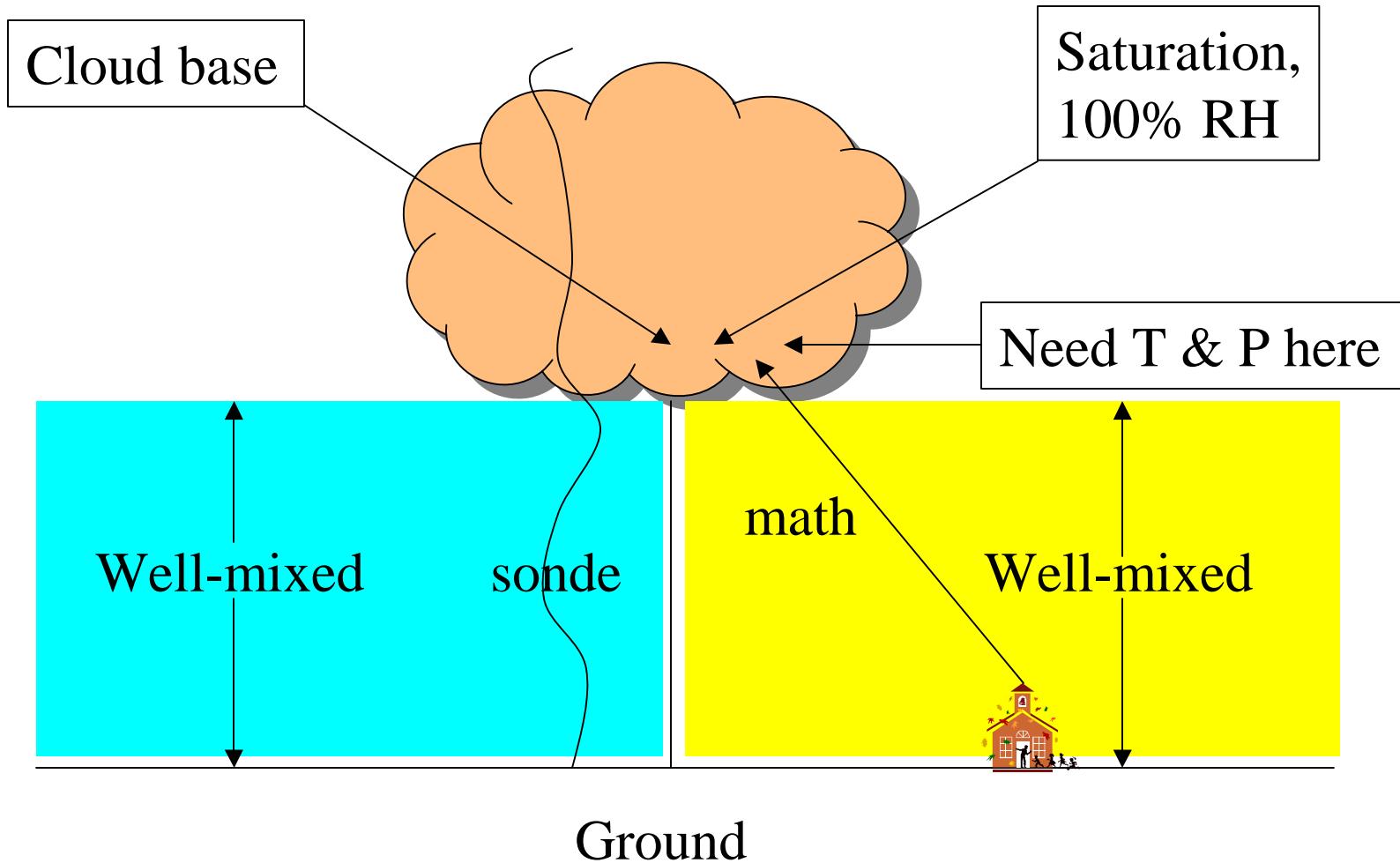


SRL System Calibration

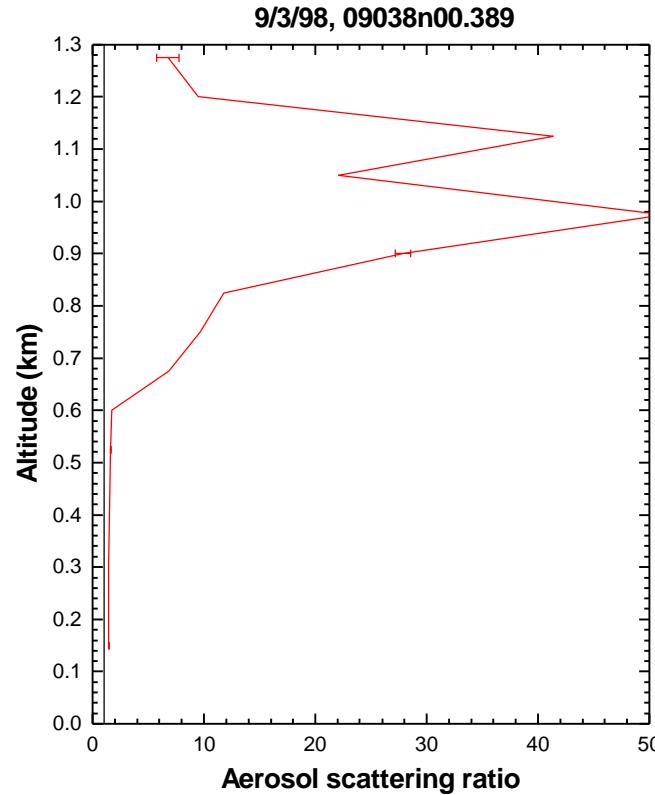
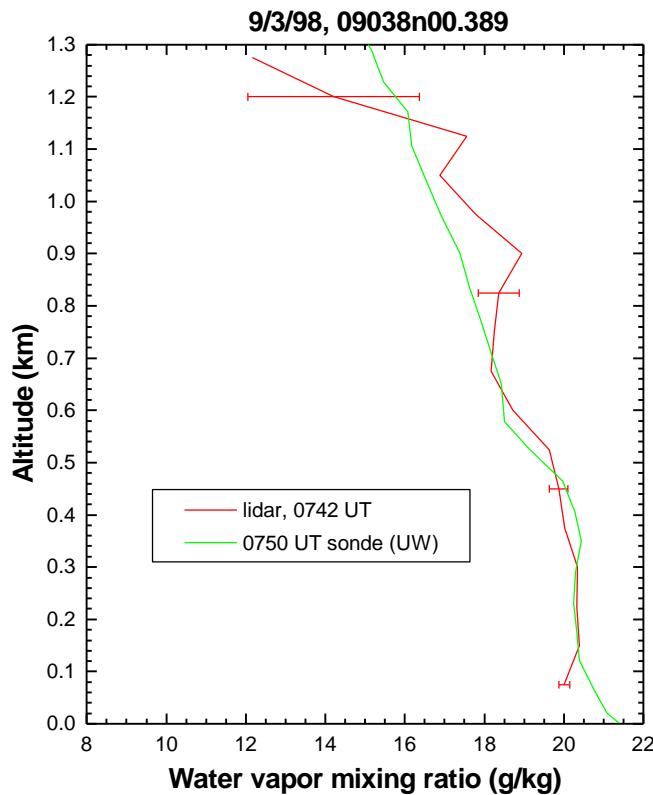
- Before 1998, cals $\pm 4\%$ wrt average (blue line)
- Modifications made often to improve measurements
- 1997-1998, many optical modifications



Cloud Base Calibration



Cloud Calibration Profiles



- Increase in aerosols = cloud base (right)
- Liquid water enhancement above 0.7 km (left)

Sensitivity of Cloud Base Algorithm

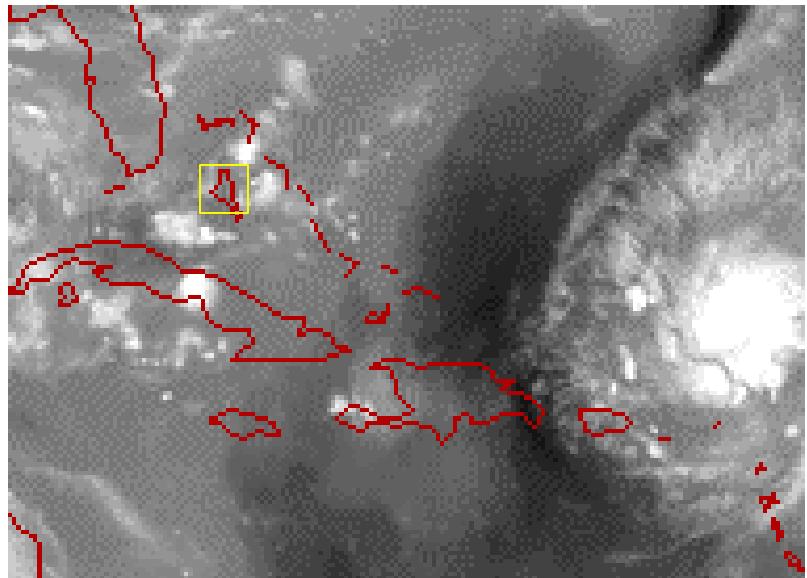
| Variable (pressure or temp.) | Difference in sat vapor pressure (mb) | Difference in water vapor conc (g/kg) | Difference in % at CAMEX-3 |
|------------------------------------|--|--|----------------------------------|
| $16 \pm 1^\circ$ | 18.2 ± 1.2 | 12.5 ± 0.9 | 7 |
| $24 \pm 1^\circ$ | 31.7 ± 1.7 | 20.7 ± 1.3 | 6 |
| 880 ± 10 hPa | ----- | ± 0.2 | 1-2 |
| 930 ± 10 hPa | ----- | ± 0.2 | 1-2 |

Calibration Comparison

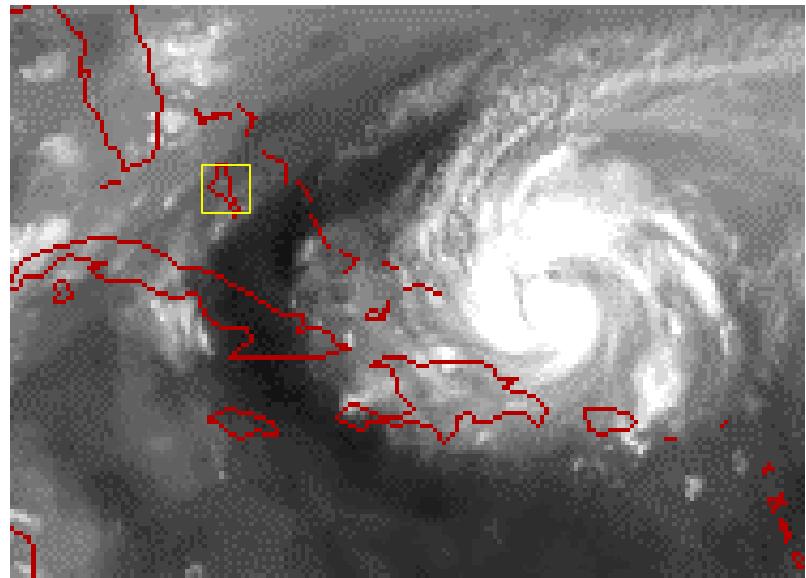
| Data type | Cal val | Std dev | % diff |
|------------------------|---------|---------|--------|
| Vaisala (corrected) | 23.11 | 1.24 | -0.03 |
| VIZ | 23.25 | 1.85 | 0.6 |
| Surface T & P | 21.50 | 0.72 | -7.1 |
| CB cal w/ sonde T&P | 23.12 | 0.72 | ----- |

GOES water vapor images

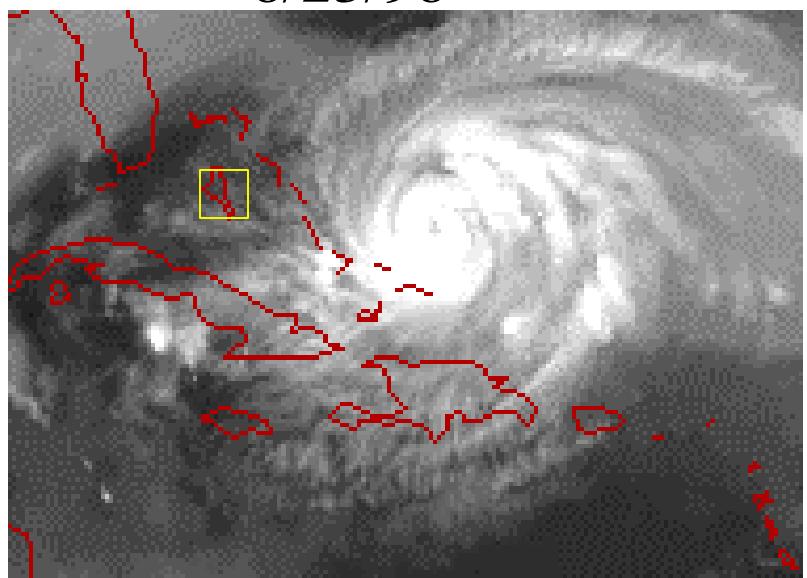
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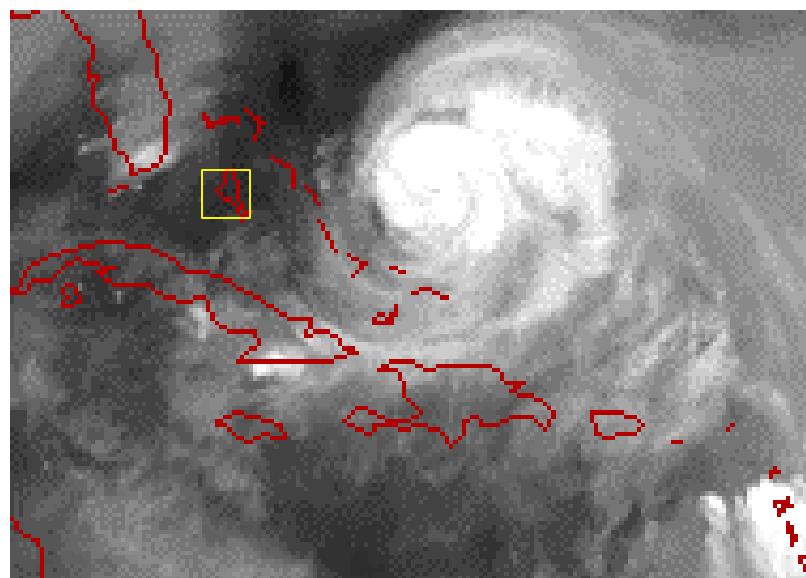
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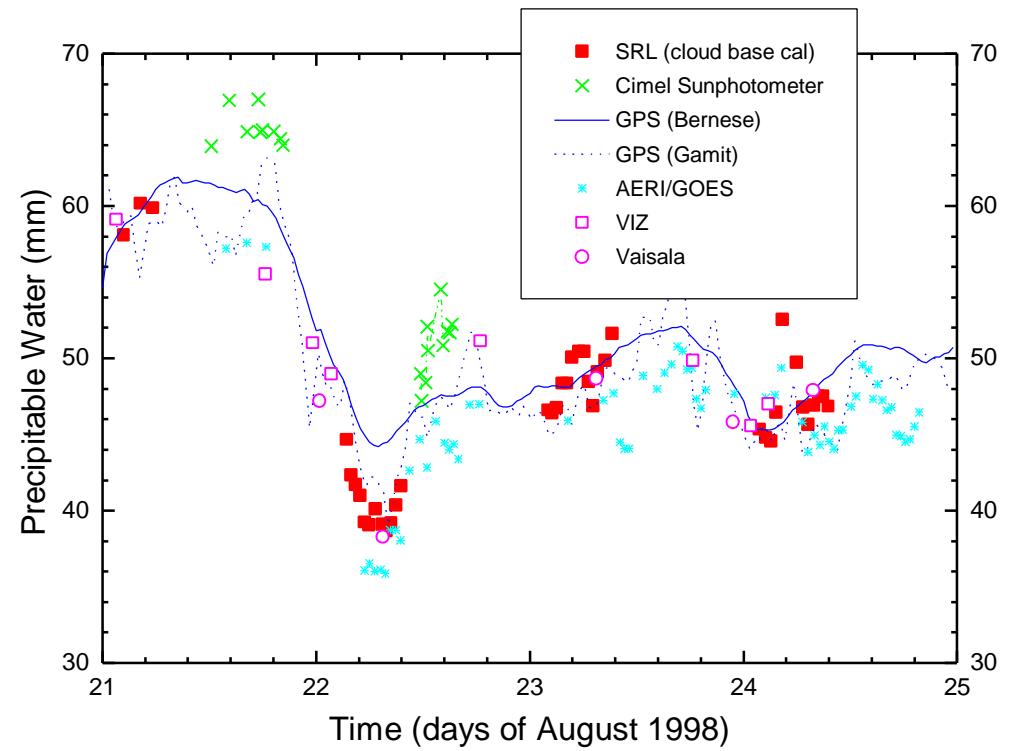
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Precipitable Water Vapor Comparison

Instruments

- SRL w/ cloud base cal (red)
- AERI/GOES (cyan)
- Cimel sunphotometer (green)
- Vaisala (magenta squares)
- VIZ (magenta circles)
- GPS (GAMIT) (blue solid)
- GPS (Bernese) (blue dashed)

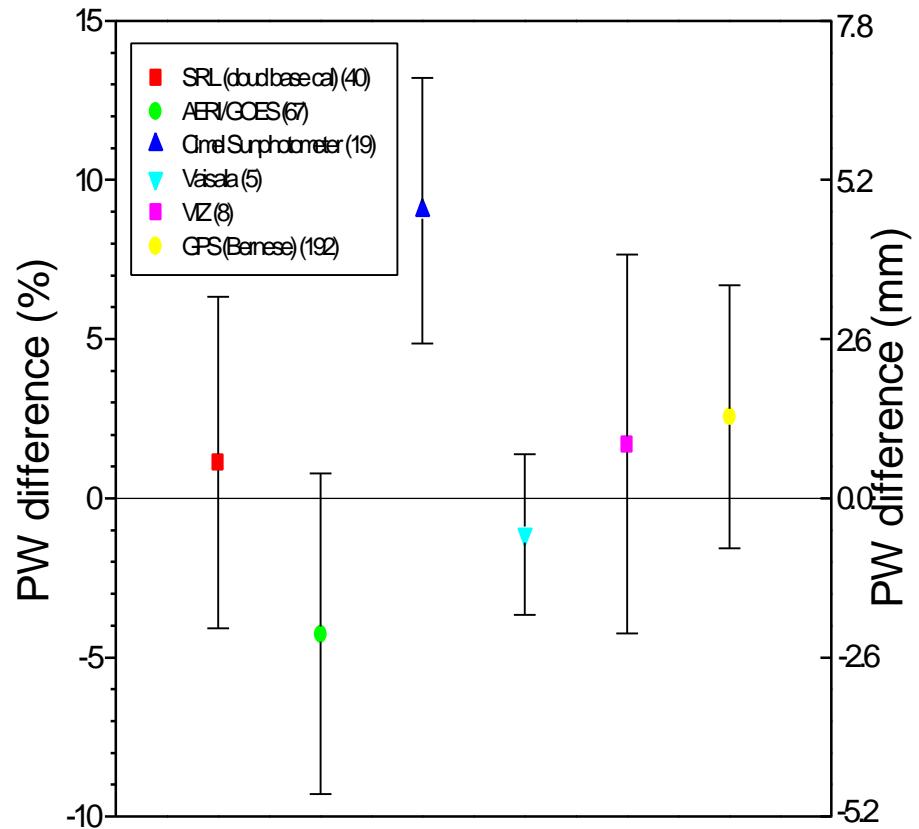


All instruments show mid-tropospheric drying

Precipitable Water Vapor Differences

Using GPS (GAMIT method) as a reference, differences in PW are Shown:

- SRL
- GPS (Bernese method)
- Cimel Sunphotometer
- Vaisala radiosondes
- VIZ radiosondes
- AERI/GOES data.



Summary and Conclusions

- A reliable, physically-based calibration technique – not dependent on other water vapor measurement - achieved
- Technique independent of sondes if use surface temp. and press.
- Showed subtropical lapse rates near hurricanes not dry adiabatic
- All instruments on Andros show drying due to Hurricane Bonnie